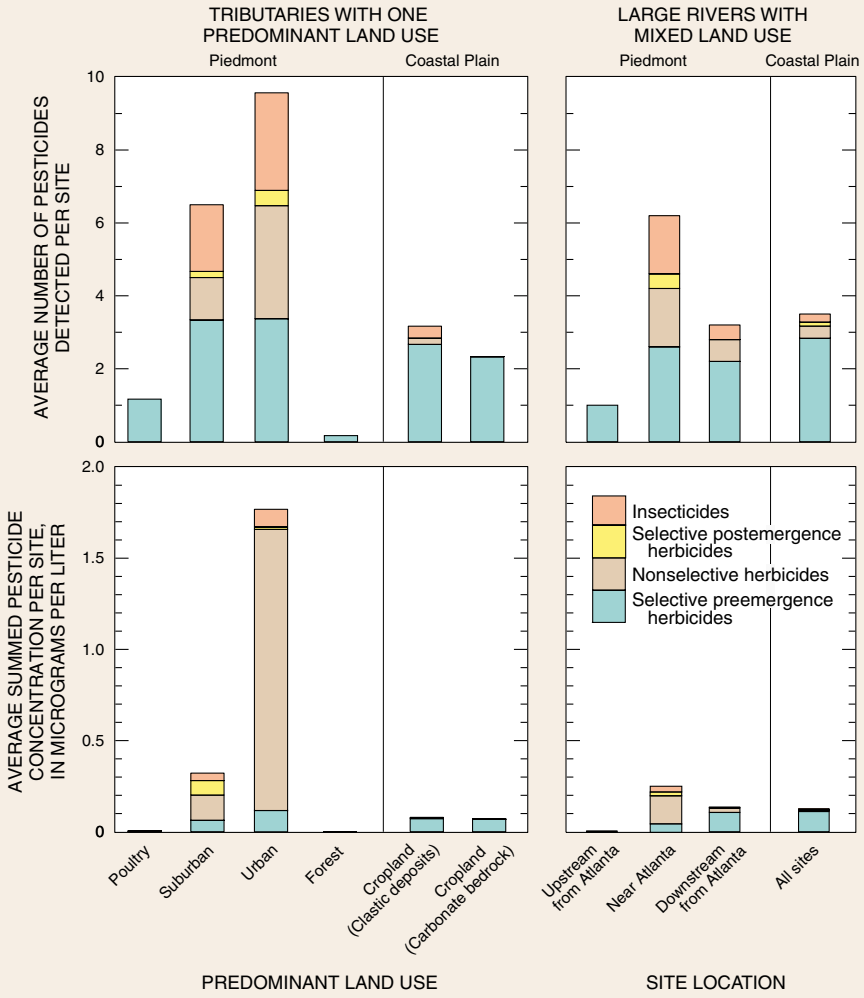
The land-use-based design of the ACF River Basin NAWQA study and use of highly sensitive analytical methods have provided an improved understanding of the occurrence and distribution of a broad range of pesticides in streams and selected aquifers in the ACF River Basin. Spatial and temporal patterns of pesticide occurrence in streams and ground water are described and associated in part with land use and pesticide use. The pesticides used have a broad range of chemical and physical properties that also control their temporal and spatial occurrence in the basin.

Pesticides are used to control weeds, insects, and plant diseases in each of the major land-use areas of the ACF River Basin (Stell and others, 1995). An estimated 17 million pounds of 147 different pesticide active ingredients are applied annually to agricultural land in the 20,000-square-mile study area (Anderson and Gianessi, 1995). Unlike much of the Nation, pesticides are applied throughout much of the year in the ACF River Basin and include similar quantities of herbicides, insecticides, fungicides, soil fumigants, and harvest aids.

Pesticides are widely used to control weeds, insects, and plant diseases in the ACF River Basin.



Herbicides that provide selective preemergence weed control are widely used in the ACF River Basin; they are the predominant type of pesticide detected in streams draining forested and agricultural areas. Streams draining suburban and urban areas, and large rivers located near and downstream from urban areas contain a more diverse mixture and higher concentrations of pesticides than other areas of the ACF River Basin, and includes compounds that are used for insect control and selective preemergence and postemergence weed control and nonselective weed control.

In the ACF River Basin, spatial surveys (results shown above) indicate that pesticides are most prevalent in streams draining areas of suburban and urban land use. Streams in these areas contain compounds used to control a broad range of pests, including: herbicides used for selective preemergence and postemergence weed control on turf; herbicides used for nonselective control of weeds, shrubs, and trees in transportation and utility right-of-way; and insecticides used to control pests in gardens, grass, ornamental shrubs, trees, and structures. In streams draining agricultural areas, herbicides used for selective preemergence weed control predominate, despite the extensive use of other types of pesticides. The spatial data indicate that the continued urbanization of forested and pasture land surrounding Metropolitan Atlanta (page 4) are likely to be accompanied by increasing numbers and concentrations of pesticides in area streams, including the area's source of drinking water.

Pesticide concentrations in streamwater samples from all major land uses in the ACF River Basin were less than

USEPA standards and guidelines for lifetime exposure in drinking water (Nowell and Resek, 1994). However, concentrations of one or more insecticides in streams draining areas of suburban and urban land use often exceeded existing chronic exposure criteria for protection of freshwater aquatic life. Insecticides are but one of several potential chemical and physical stressors that exist in these streams.

The highest measured concentrations of most pesticides coincided with the growing season, from March through October, when many of these compounds are used. However, the highest measured concentrations of several herbicides used for selective preemergence weed control in suburban and urban areas peaked during the winter months—these compounds are applied to lawns during fall and winter months to control winter weeds. Winter applications of selective preemergence herbicides on turf coincide with periods of high base flow and frequent stormflows and may contribute to higher concentrations and quantities of these pesticides in streams relative to other pesticides applied during the growing season.

Some pesticides persisted in streams within the ACF River Basin well beyond their normal application periods. These compounds include some selective preemergence herbicides, nonselective herbicides, and insecticides used on suburban and urban land; and some selective preemergence herbicides used on agricultural land. Insecticides commonly were present throughout the year in streams draining areas of suburban and urban land use, and in large streams that receive runoff from urban areas. Concentrations of one or more of these insecticides (primarily diazinon, carbaryl, chlorpyrifos, and malathion) exceeded existing guidelines for protection of aquatic life throughout the year in streams draining these areas (Hippe and others, 1995).

Most pesticides present in streams draining major land uses in the ACF River Basin have chemical and soil properties that cause them to have a greater potential to run off than other less frequently detected compounds. Pesticides used for selective preemergence weed control and nonselective weed control, in particular, are rather water soluble and persist in soils following applications to provide seasonal or longer term weed control—these properties also increase their potential to run off to streams relative to other compounds. Herbicides that are used for nonselective weed control are applied at up to 10 times the rate of similar compounds used for selective weed control—these higher rates also may increase their potential to be present in nearby streams.

Sope Creek—a predominantly suburban watershed (29 square miles) in Metropolitan Atlanta

Compound detected*	Frequency of detection, in percent	Maximum concentration (µg/L)	January	February	March	April	May	June	July	August	September	October	November	December
Selective preemergence herbicides														
Atrazine	96	.38												
Benfluralin	14	.022												
Metolachlor	15	.068												
Pendimethalin	42	.24												
Pronamide	10	.021												
Simazine	94	8.2												
Trifluralin	15	.019												
Selective postemergence herbicides														
MCPA	19	.42												
2,4-D	20	.63												
Nonselective herbicides			(no particular application period)											
Prometon	59	.86												
Tebuthiuron	68	.16												
Insecticides														
Carbaryl	63	.24												
Chlorpyrifos	61	.051												
Diazinon	92	.45												
Malathion	14	.14												

*Additional pesticides that were less frequently detected (less than 10 percent of 71 samples analyzed): DCPA, deethylatrazine, napropamide, oryzalin, propanil, trichlopyr, 2,4-DB, bromacil, diuron, terbacil, p,p-DDE, ethoprop, lindane, parathion, propoxur

Lime Creek—a predominantly cropland watershed (62 square miles) in southwest Georgia

Compound detected*	Frequency of detection, in percent	Maximum concentration (µg/L)	January	February	March	April	May	June	July	August	September	October	November	December
Selective preemergence herbicides														
Alachlor	21	0.011												
Atrazine	64	0.21												
Cyanazine	12	0.77												
Deethylatrazine	25	.007												
Fluometuron	21	1.6												
Metolachlor	66	0.34												
Norflurazon	14	1.4												
Simazine	47	0.16												
Trifluralin	21	0.20												
Nonselective herbicide			(no particular application period)											
Tebuthiuron	23	0.050												
Insecticide														
Fonofos	10	1.2												

*Additional pesticides that were less frequently detected (less than 10 percent of 73 samples analyzed): benfluralin, bentazon, butylate, ethylfluralin, metribuzin, pendimethalin, 2,4-D, p,p-DDE, malathion, ethoprop, carbaryl, and chlorothalonil

EXPLANATION

Month when pesticide:

Application is recommended

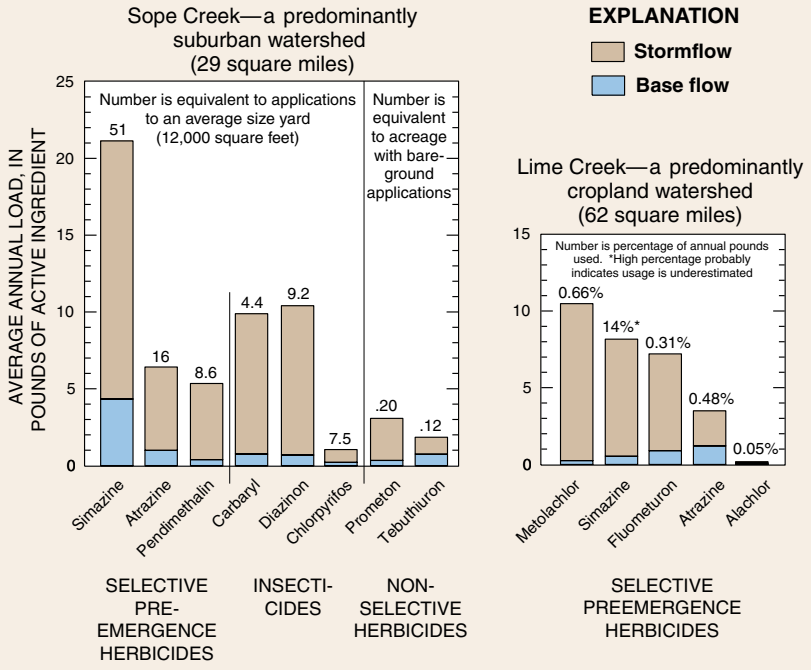
Was detected

Detected at highest concentration

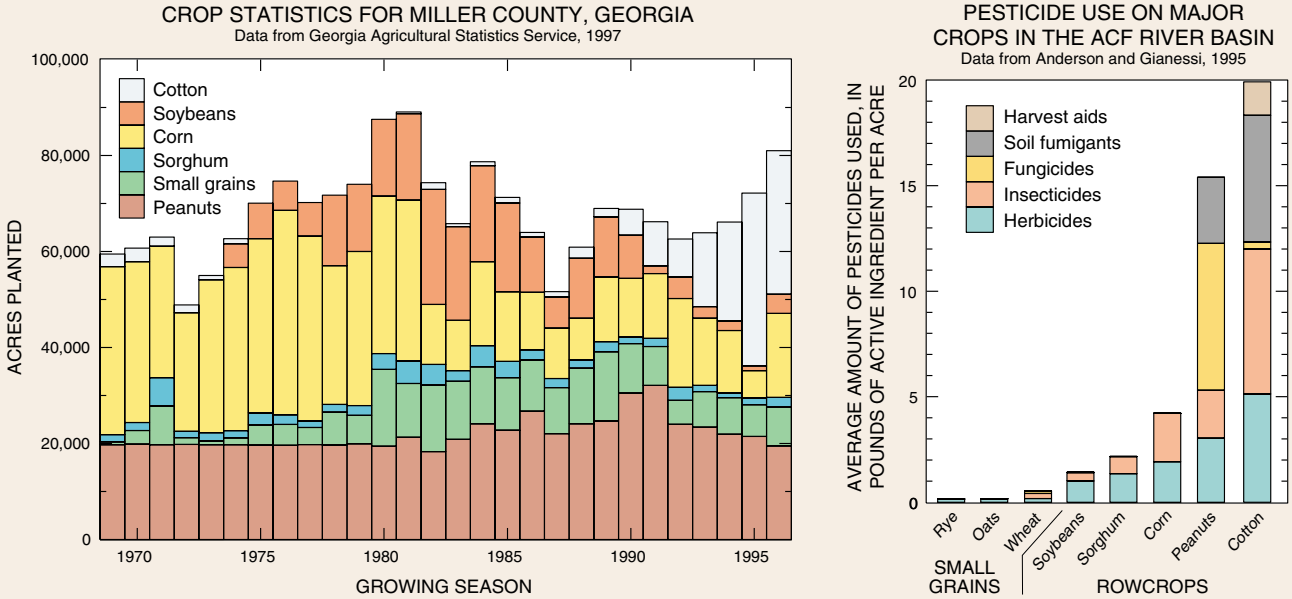
Maximum measured concentrations of most pesticides coincided with application periods to turf in the suburban watershed and to peanuts, cotton, and corn in the watershed dominated by cropland. Pesticide concentrations generally decreased to less than detectable levels during other parts of the year. However, several compounds persisted throughout the year in the suburban watershed.

Stormflows transport from 60 to 90 percent of the total quantity of pesticides carried by streams draining urban and agricultural land in the ACF River Basin. Large storms that coincide with pesticide application periods in particular transport much of the annual pesticide loads in streams within the basin.

Several minor crops are grown in the ACF River Basin including pecans (shown above), peaches, melons, cucumbers, squash, tomatoes, snap beans, sweet peppers, and collard greens. About 3.2 million pounds of pesticides are used annually on these crops (Anderson and Gianessi, 1995). (Photograph is by Debbie Warner, USGS.)



Storm runoff carries much of the pesticides transported by streams draining cropland and suburban land. The quantities of pesticides transported are low relative to the quantities applied because pesticides are primarily retained in the soil and degraded or are transported from these watersheds by other pathways.



In the ACF River Basin, plantings of cash crops vary from year to year in response to changing weather and market conditions. From 1992 to 1995, cotton plantings increased by over 400 percent in many counties, in response to increasing demand for cotton lint and improved cotton yields resulting from eradication of the boll weevil. Because cotton acreage generally uses more pesticides than the corn and soybean acreage it displaced, the recent changes in crop patterns have caused a substantial increase in the quantity and number of pesticides applied to cropland in the basin.